ABSTRACT

Title: Liberation Characteristics of Pyrite and Other Mineral Matter from Coal

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Previous work on this project has led to the development of a reliable image analysis technique based on SEM images that can be used to quantify the mineralogical texture of coal samples and which can be used to generate accurate images of coal particles. The mineralogical texture characterization is based on three components: pyrite, ash-forming minerals and coal. The method relies entirely on the measured linear distributions measured on each phase in polished section and simultaneously on the transition probabilities among the three species as a linear probe passes through the texture. The latter information essentially quantifies the associations among the three mineral phases. The liberation characteristics of any sample of coal can be predicted using a collection of integrals of the linear intercept distributions together with the transition probabilities. The method is based on making a prediction of the distribution of linear grades in comminuted coal particles and then using a stereological correction method to reconstruct the volumetric distribution of particle grades. The stereological correction for three component systems, developed as part of this project, was described in detail in our presentation to the previous UCR Contractor's Review Meeting. For example, the probability of observing a three phase linear intercept of length ℓ through a coal particle that has mineral matter content $\leq m$, pyrite content $\leq p$ and which has the components associated in the order mineral matter, coal then pyrite is given by

$$\upsilon_m P_{mc} P_{cp} \int_0^{p\ell} \frac{\bar{F}_p(u)}{\mu_p} du \int_0^{m\ell} \frac{\bar{F}_m(w)}{\mu_m} F_c(\ell - w)\, dw$$

Where F_i represents the cumulative measured distribution of linear intercepts through component i in the unbroken coal. The evaluation of these integrals using modern symbolic mathematics software (Maple) has been investigated during the past year. Effective analytical expressions that are easy to evaluate have been found using this software when F is a sum of exponentials. Other

promising functional forms that describe the experimentally determined linear intercept distributions are now under investigation. With a complete set of integrals of the above type in hand, to describe every possible linear intercept, it is a straightforward procedure to implement the stereological correction method to generate the complete liberation spectra as a function of particle size.

The main focus of investigation during the past year has been the measurement and modeling of the three-component Andrews-Mika diagram. This diagram provides a graphical representation of the cross transition coefficients that are used in all population balance models of comminution operations when mineral liberation is important. The experimental determination of the data that generates the Andrews-Mika diagram is an exacting procedure. Fractionated samples of monosize samples of coal are carefully broken in a laboratory mill and the liberation spectra of a complete set of progeny are measured using image analysis and stereological correction.

A theoretical model for the 3-component Andrews-Mika diagram has been developed. Like its 2-component counterpart, this model has two components: the boundary structure of the attainable region and its internal structure. The boundary structure is developed on the basis of the following principle. The size of the largest particle of any liberated component in the progeny of a breakage event cannot exceed the size of the largest coherent grain of that component in the parent particle. The application of this principle leads to a boundary structure for the attainable region as shown in Figure 1. The inner structure is modeled by a 3-component distribution that is censored at the edge boundaries and which has natural boundaries on the interior curved surfaces of Figure 1. The stereologically corrected data from the progeny particles is the basic data for the estimation of the parameters in the model of the Andrews-Mika diagram

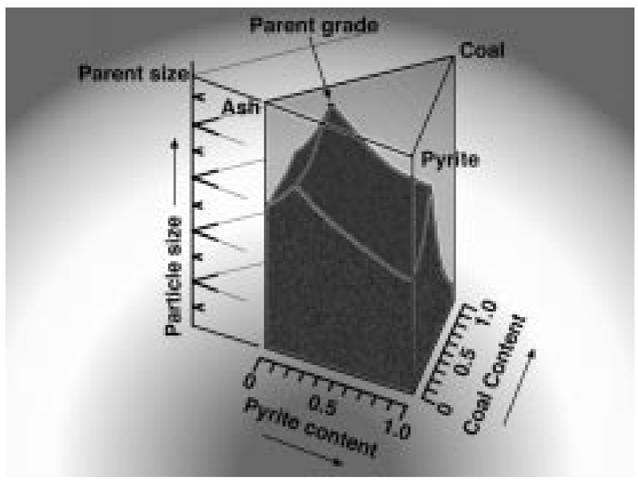

Figure 1 *Boundaries of the Andrews-Mika diagram for a 3-component system.*

Publications

King, R. P. and Schneider, C. L. Comparison of Stereological Correction Procedures for liberation measurements. Transactions of the Institution of Mining and Metallurgy. 104, pp C155-C161, 1997

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King R. P. Progress in the prediction, measurement and simulation of liberation. Keynote Lecture: Comminution '98, Brisbane February 1998. To be published in *Minerals Engineering*, 1998

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Student supported on this Project

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